

What is Claimed is:

- 1 1. A method of selecting paths comprising the steps of:
 - 2 a) computing a plurality of first shortest paths from a source point to a destination point
 - 3 each including of a serial chain of at least one communications link;
 - 4 b) selecting K first shortest paths from the plurality;
 - 5 c) ordering the selected K first shortest paths from shortest to longest;
 - 6 d) for each first shortest path of K,
 - 7 i) computing the cost of the first shortest path as substantially equal to the
 - 8 combined cost of the links included in the first shortest path;
 - 9 ii) selecting a lowest estimated cost second shortest path from the
 - 10 remainder of the elements of K, where the estimated cost of the second
 - 11 shortest path is computed as substantially equal to the combined
 - 12 estimated cost of the links included in the second shortest path and the
 - 13 cost of a link corresponds to the cost of using the link scaled by a
 - 14 probability that the link can be shared by the second shortest path and a
 - 15 path already provisioned using a channel of the link;
 - 16 e) selecting the lowest estimated combined cost first and second shortest path pair.
- 1 2. The method according to claim 1, wherein for a second shortest path, the cost of a link is
- 2 estimated by;
 - 3 a) assigning an infinite cost to a link included in an associated first shortest path;
 - 4 b) assigning an infinite cost to a link that traverses at least one shared-risk-group (SRG)
 - 5 traversed by an associated first shortest path;

- 6 c) assigning to a link not having an available shared protection channel a cost
7 substantially equal to the cost of allocating an additional shared protection channel to
8 the link;
- 9 d) estimating for a link having at least one available shared protection channel a cost
10 corresponding to the cost of using the link scaled by a probability that the link can be
11 shared by the second path under consideration and no backup paths already
12 provisioned using the link.
- 1 3. The method of claim 2 wherein the probability that the link can be shared by the second path
2 under consideration and no backup path already provisioned using the link is determined
3 according to a method comprising;
- 4 a) creating a variable M, and assigning as its value the number of available shared
5 protection channels in the link;
- 6 b) for each j from 1 to N;
- 7 i) creating an array of N elements, SRG_j , consisting of the N SRGs
8 traversed by a proposed primary path;
- 9 ii) creating an array of N elements, n_j , consisting of the number of times
10 SRG_j is traversed by a primary path protected by a backup path already
11 provisioned using channels of the link;
- 12 c) computing a probability, p, that one available shared protection channel of a link can
13 be shared by a second shortest path and one backup path already provisioned using
14 the channel as $p = \prod_j (1 - n_j/M)$, for j from 1 to N;
- 15 d) computing a probability, P, that no available shared protection channel of a link can
16 be shared by a second shortest path with a backup path already provisioned using a
17 channel of the link as $P = (1-p)^M$.

- 1 4. The method according to claim 1, wherein the lowest cost path pair is selected according to a
2 method comprising;
- 3 a) defining an array of K elements, w_i , where i ranges from 1 to K, including the ordered
4 K first selected paths;
- 5 b) defining an array of K elements, s_i , where i ranges from 1 to K, including the K
6 second shortest paths associated with the ordered K first selected paths;
- 7 c) defining a set, K, comprised of elements $\{w_i, s_i\}$, where i ranges from 1 to K;
- 8 d) computing the combined estimated cost of the elements of set K, and ordering the
9 elements from lowest combined estimated cost to highest combined estimated cost;
- 10 e) selecting the lowest combined estimated cost path pair in set K.

- 1 5. A method of selecting paths comprising the steps of:
- 2 a) creating a first graph representing a network having a topology containing network
3 elements interconnected by communications links wherein each network element is
4 represented by a vertex and each communication link interconnecting adjacent
5 network elements is represented by an edge, the first graph containing a source
6 vertex corresponding to an ingress network element and a destination vertex
7 corresponding to an egress network element;
- 8 b) using the first graph to calculate a plurality of paths between the source and
9 destination vertices;
- 10 c) selecting K first shortest paths between source vertex and destination vertex;
- 11 d) for each first shortest path;
- 12 i) computing the cost of the first shortest path;

6 ii) assigning to an edge without an available shared protection channel a cost
7 substantially equal to the cost of adding an additional shared protection
8 channel to the edge;

9 iii) estimating for an edge having at least one available shared protection
10 channel a cost corresponding to the cost of using the edge scaled by a
11 probability that the edge can be shared by the second path under
12 consideration and no backup paths already provisioned using the edge.

1 11. The method of claim 10 wherein a probability that an edge can be shared by a second
2 shortest path and no backup paths already provisioned using channels of an edge is
3 estimated by;

4 a) creating a variable, M, and setting its value to the number of available shared
5 protection channels in the edge;

6 b) for each j, where j ranges from 1 to N;

7 i) creating an array of N elements, SRG_j , consisting of the N SRGs
8 traversed by a proposed primary path;

9 ii) creating an array of N elements, n_j , each consisting of the number of
10 times SRG_j is traversed by a primary path protected by a backup path
11 already provisioned using channels of the edge;

12 c) computing a probability, p, that one available shared protection channel of an edge
13 can be shared by a second shortest path and one backup path already provisioned
14 using the channel as $p = \prod_j (1 - n_j / M)$;

15 d) computing a probability, P, that no available shared protection channel of an edge
16 can be shared by a second shortest path with a backup path already provisioned
17 using a channel of the edge as $P = (1 - p)^M$.

1 12. The method of claim 5, wherein a lowest estimated combined cost first and second shortest
2 path pair is selected according to a method comprising;

3 a) creating a set, S, with K elements $\{w_i, s_i\}$, where i ranges from 1 to K, including the K
4 first shortest paths, w_i , and K associated selected second shortest paths, s_i ;

5 b) for each first shortest path, w_i , where i ranges from 1 to K;

6 i) computing a cost substantially equal to the combined cost of the links
7 included in the first shortest path;

8 ii) computing an estimated cost for the associated selected second shortest
9 path substantially equal to the combined estimated cost of the links
10 comprising the selected second shortest path;

11 c) ordering the elements of set S from lowest combined estimated cost to highest
12 combined estimated cost;

13 d) selecting the lowest combined estimated cost path pair.

1 13. A shared mesh protection network wherein paths are provisioned according to a method
2 comprising;

3 a) generating a list of at least one candidate pair of paths including one primary path
4 and one associated backup path between a source network element and a
5 destination network element;

6 b) selecting a lowest estimated path pair from the list where the cost of the primary path
7 is substantially equal to the cost of the network resources included in the primary
8 path and the estimated cost of a backup path corresponds to the cost of the network
9 resources included in the backup path scaled by the probability that existing network
10 resources can be shared by the backup path;

- 11 c) using signaling to attempt to establish the selected path pair;
- 12 d) eliminating the selected path pair from the list if it can not be established and
- 13 attempting to establish a new lowest estimated cost path pair;
- 14 e) returning an error signal to a network operator if no candidate path pair from the list
- 15 can be allocated.

1 14. The network of Claim 13 wherein path provisioning is controlled by the source network
2 element and signaling is used between the source network element and each network
3 element in a proposed pair of primary and backup paths to establish links between adjacent
4 network elements.

1 15. The network of claim 14, wherein said signaling is comprised of the steps of;

2 a) for each network element in the primary path, sending from the source network
3 element to the network element a request for the network element to establish a link
4 with adjacent network elements;

5 b) for each network element in the backup path, sending from a source network element
6 to the network element a request for the network element to establish a link with
7 adjacent network elements;

8 c) for each network element in the primary path that can not establish a link to an
9 adjacent network element, sending from the network element to the source network
10 element an error signal;

11 d) for each network element in the primary path that can establish a link to an adjacent
12 network element, sending from the network element to the source network element a
13 valid link signal;

1 16. The network of Claim 13 wherein the network has a single network controller and signaling
2 between the controller and network elements is used to provision primary and backup paths.

1 17. The network of claim 13, wherein reallocation of existing network resources is initiated at any
2 time.

1 18. The network of claim 13, wherein reallocation of existing network resources is initiated at
2 each request of new communications service.

1 19. The network of claim 13, wherein reallocation of existing network resources is initiated at
2 regularly scheduled intervals.

3